

REMARKS/ARGUMENTS

The Examiner is thanked for the thorough examination and search of the subject.

5 Claims 92-129 and 151-164 are pending. Claims 92, 93, 96, 97, 99-123,
125-129, 151-154 and 156-162 are currently amended. Claims 94, 95, 98, 124 and 155
are currently amended but withdrawn. Claims 163 and 164 are newly added. Claims
1-91 and 130-150 are canceled.

Response to Claim Rejections under 35 U.S.C. 112

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*Reconsideration of Claims 92, 93, 96, 97, 99-123, 125-129, 151-154 and 156-162
rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written
description requirement is requested based on the following remarks.*

15 Withdrawal of rejection under 35 U.S.C. 112, first paragraph, to Claims 92, 93, 96,
97, 99-123, 125-129, 151-154 and 156-162 is respectfully requested as Claims 92, 93, 96,
97, 99-123, 125-129, 151-154 and 156-162 are currently amended.

Response to Claim Rejections under 35 U.S.C. 102 and 103

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Applicants respectfully traverse the rejections for at least the reasons set forth
below.

Response to Claims 92-119

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As currently amended, independent claim 92 is recited below:

92. A semiconductor device comprising:

a pad having a region exposed by an opening in a passivation layer;

a metal pillar over all of said region; and

a tin-containing cap over said metal pillar, wherein said tin-containing cap

5 has a greatest transverse dimension less than a transverse dimension of said metal pillar.

10 *Reconsideration of Claims 92, 93, 96, 97, 99-119 rejected under 35 U.S.C. 103(a) as being unpatentable over Ogura (US6,706,554) in combination with Burnette et al. (US6,552,436) is requested based on the following remarks.*

15 Applicants respectfully assert that the semiconductor device claimed in claim 92 patentably distinguishes over the citations by Ogura (US6,706,554) and Burnette et al. (US6,552,436).

20 Ogura teaches that a semiconductor device comprises a pad 14 having a region exposed by an opening in a passivation layer 12; a metal pillar 22 over said region; and a solder cap 26 over said metal pillar 22, wherein said solder cap 26 has a greatest transverse dimension less than a transverse dimension of said metal pillar 22. ~ See Fig. 1H~

25 Ogura teaches that said metal pillar 22 is over **PART** of said region exposed by said opening in said passivation layer 12, but fails to teach said metal pillar 22 can be over **ALL** of said region exposed by said opening in said passivation layer 12, as claimed in claim 92. Applicants emphasize that said metal pillar is over all of said region exposed by said opening in said passivation layer 12, leading said pad 14 not exposed to the ambient, and thereby damaging said pad 14 by moisture or contaminant can be improved,

which is not anticipated by Ogura but is claimed in Claim 92.

Ogura teaches a pillar-shaped bonding structure is formed over an IC chip; however, Burnette et al. teach a solder ball 24 or 44, not comprising a pillar-shaped pillar, is used to connect a substrate 12 or 32 and a printed circuit board 22 or 42, that is, not formed over an IC chip. ~ See Figs. 1 and 2, and col. 1, lines 29-31 and 52-54 ~ Ogura and Burnette et al. teach different ways for bonding different circuit components.

The Examiner considers that "Both references deal with flip chips interconnected to a substrate. Therefore, one of ordinary skill in the art would be motivated to look at art in an effort to insure protection of its substrate's unerlyalers. The fact that the interconnect is a different shape does not eliminated the motive a person of ordinary skill in the art looking at references that deal with problems of interconnection would have in an effort to establish the most reliable connections. For the reasons stated, applicant's arguments are deemed unpersuasive". ~ See lines 4-10, in the last paragraph, on page 7, in the last Office Action mailed Jul. 25, 2006 ~

Applicants respectfully traverse the Examiner's opinions because **NOT** both references deal with flip chips interconnected to a substrate. Ogura teaches a pillar-shaped bonding structure is used to connect an IC chip and an external circuit component; however, Burnette et al. teach a solder ball not comprising a metal pillar is used to connect a substrate and a printed circuit board, that is, not to connect an IC chip and an external circuit component. As a result, it is believed that Ogura's device can not be combined with Burnette et al.'s device because Burnette et al.'s reference does not deal with flip chips interconnected to a substrate. Withdrawal of rejection under 35 U.S.C. 103 (c) to Claim 92 is respectfully requested.

For at least the foregoing reasons, applicants respectfully submit independent claim

92 patently distinguishes over the prior art references, and should be allowed. For at least the same reasons, dependent claims 93-119 patently define over the prior art as well.

Response to Claims 120-129 and 163

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As currently amended, independent claim 120 is recited below:

120. A semiconductor device comprising:

a pad exposed by an opening in an insulating layer;

10 a copper pillar over said pad; and

a tin-containing cap over said copper pillar, wherein said tin-containing cap has a greatest transverse dimension less than that of said copper pillar.

15 *Reconsideration of Claims 120-123 and 125-129 rejected under 35 U.S.C. 103(a) as being unpatentable over Ogura (US6,706,554) in combination with Burnette et al. (US6,552,436) is requested based on the following remarks.*

Applicants respectfully assert that the semiconductor device claimed in claim 120
20 patentably distinguishes over the citations by Ogura (US6,706,554) and Burnette et al. (US6,552,436).

Ogura teaches that a semiconductor device comprises a pad 14 exposed by an opening in a passivation layer 12; a metal pillar 22 over said pad 14; and a solder cap 26
25 over said metal pillar 22, wherein said solder cap 26 has a greatest transverse dimension less than a transverse dimension of said metal pillar 22. ~ See Fig. 1H ~

Ogura teaches that said metal pillar 22 comprises aluminum, titanium, tungsten,

molybdenum, gold, silver, nickel, indium, or silicon. ~ See *1H*, and col. 4, lines 58-63 ~
However, Ogura fails to teach, hint or suggest that said metal pillar 22 may comprise copper, as claimed in Claim 120.

5 Ogura teaches a pillar-shaped bonding structure is formed over an IC chip; however, Burnette et al. teach a solder ball 24 or 44, not comprising a pillar-shaped metal pillar, is used to connect a substrate 12 or 32 and a printed circuit board 22 or 42, that is, not formed over an IC chip. ~ See *Figs. 1 and 2, and col. 1, lines 29-31 and 52-54* ~
Ogura and Burnette et al. teach different ways for bonding different circuit components.

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15 in the art looking at references that deal with problems of interconnection would have in an effort to establish the most reliable connections. For the reasons stated, applicant's arguments are deemed unpersuasive". ~ See lines 4-10, in the last paragraph, on page 7, in the last Office Action mailed Jul. 25, 2006 ~

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25 and an external circuit component. As a result, it is believed that Ogura's device can not be combined with Burnette et al.'s device because Burnette et al.'s reference does not deal with flip chips interconnected to a substrate. Withdrawal of rejection under 35 U.S.C. 103 (c) to Claim 92 is respectfully requested.

For at least the foregoing reasons, applicants respectfully submit independent claim 120 patentably distinguishes over the prior art references, and should be allowed. For at least the same reasons, dependent claims 121-129 and 163 patentably define over the prior art as well.

Response to Claims 151-162 and 164

As currently amended, independent claim 151 is recited below:

151. A semiconductor device comprising:

a pad exposed by an opening in an insulating layer;

a metal pillar over said pad, wherein said metal pillar comprises a tin-silver-copper alloy; and

a tin-containing cap over said metal pillar.

Reconsideration of Claims 151-154 and 156-162 rejected under 35 U.S.C. 103(a) as being unpatentable over Ogura (US6,706,554) in combination with Burnette et al. (US6,552,436) is requested based on the following remarks.

Applicants respectfully assert that the semiconductor device claimed in claim 151 patentably distinguishes over the citations by Ogura (US6,706,554) and Burnette et al. (US6,552,436).

Ogura teaches that a semiconductor device comprises a pad 14 exposed by an opening in a passivation layer 12; a metal pillar 22 over said pad 14; and a solder cap 26 over said metal pillar 22, wherein said solder cap 26 has a greatest transverse dimension

less than a transverse dimension of said metal pillar 22. ~ See Fig. 1H ~

Ogura teaches that said metal pillar 22 comprises aluminum, titanium, tungsten, molybdenum, gold, silver, nickel, indium, or silicon. ~ See 1H, and col. 4, lines 58-63 ~

5 However, Ogura fails to teach that said metal pillar 22 may comprise a tin-silver-copper alloy, as claimed in Claim 151.

Ogura teaches a pillar-shaped bonding structure is formed over an IC chip; however, Burnette et al. teach a solder ball 24 or 44, not comprising a pillar-shaped metal
10 pillar, is used to connect a substrate 12 or 32 and a printed circuit board 22 or 42, that is, not formed over an IC chip. ~ See Figs. 1 and 2, and col. 1, lines 29-31 and 52-54 ~
Ogura and Burnette et al. teach different ways for bonding different circuit components.

The Examiner considers that “Both references deal with flip chips interconnected
15 to a substrate. Therefore, one of ordinary skill in the art would be motivated to look at art in an effort to insure protection of its substrate’s unerlyars. The fact that the interconnect is a different shape does not eliminated the motive a person of ordinary skill in the art looking at references that deal with problems of interconnection would have in an effort to establish the most reliable connections. For the reasons stated, applicant’s
20 arguments are deemed unpersuasive”. ~ See lines 4-10, in the last paragraph, on page 7, in the last Office Action mailed Jul. 25, 2006 ~

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be combined with Burnette et al.'s device because Burnette et al.'s reference does not deal with flip chips interconnected to a substrate. Withdrawal of rejection under 35 U.S.C. 103 (c) to Claim 92 is respectfully requested.

5 For at least the foregoing reasons, applicants respectfully submit independent claim 151 patently distinguishes over the prior art references, and should be allowed. For at least the same reasons, dependent claims 152-162 and 164 patently define over the prior art as well.

10 CONCLUSION

Some or all of the pending claims are believed to be in condition for allowance. Accordingly, allowance of the claims and the application as a whole are respectfully requested.

Applicant respectfully requests that a timely Notice of Allowance be issued in this
15 case.

Sincerely yours,



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Note: Please leave a message in my voice mail if you need to talk to me. (The time in D.C. is 12 hours behind the Taiwan time, i.e. 9 AM in D.C. = 9 PM in Taiwan.)